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Author Affiliation:

¹Department of Botany, Sardar Patel University, Mandi, Himachal Pradesh, India, Email: vasunegi309@gmail.com

²G.B. Pant National Institute of Himalayan Environment (NIHE), Kosi-Katarmal, Almora, Uttarakhand, India

Corresponding Author

G.B. Pant National Institute of Himalayan Environment (NIHE), Kosi-Katarmal, Almora, Uttarakhand, India
Email: kskanwal03@gmail.com

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Diplazium esculentum (Retz.) Sw.: A traditionally used vegetable and medicinal pteridophyte of Kullu Valley in the Western Himalayas

Subodh Negi¹, Kanwal KS^{2*}

ABSTRACT

The Western Himalaya is an abode of diverse and unique floral variety, particularly flourishing with pteridophytes that have drawn attention due to their ornamental and medicinal properties in recent times. However, some fern species are traditionally used for both their food value and medicinal properties. The fronds of *Diplazium esculentum* (Retz.) Sw., locally known as 'Lingadi,' are utilized in preparing various cuisines by the local communities in the Kullu Valley of Himachal Pradesh. This fern typically grows in early spring, from March to April, in shady areas along water streams. The study focuses on assessing the diversity and distribution, wild edible values, medicinal properties, phytochemistry, and livelihood potential of *Diplazium esculentum* (Retz.) Sw. in the Kullu Valley of Himachal Pradesh. Standard methodology was followed for the study. The findings emphasize that *Diplazium esculentum* holds high nutritional value and significant traditional indigenous uses. It possesses medicinal importance, particularly immunomodulatory properties, and offers livelihood opportunities to the local communities of Himachal Pradesh. The study observed an increased demand for *Diplazium esculentum* in the past 2-3 years, particularly during the COVID-19 pandemic period in the study area. The study recommends strategies for the conservation and sustainable utilization of this important fern species in the Western Himalaya region.

Keywords: *Diplazium esculentum*, Kullu Valley, Himachal Pradesh, ethnomedicinal uses, nutritional value, livelihood opportunity, conservation.

1. INTRODUCTION

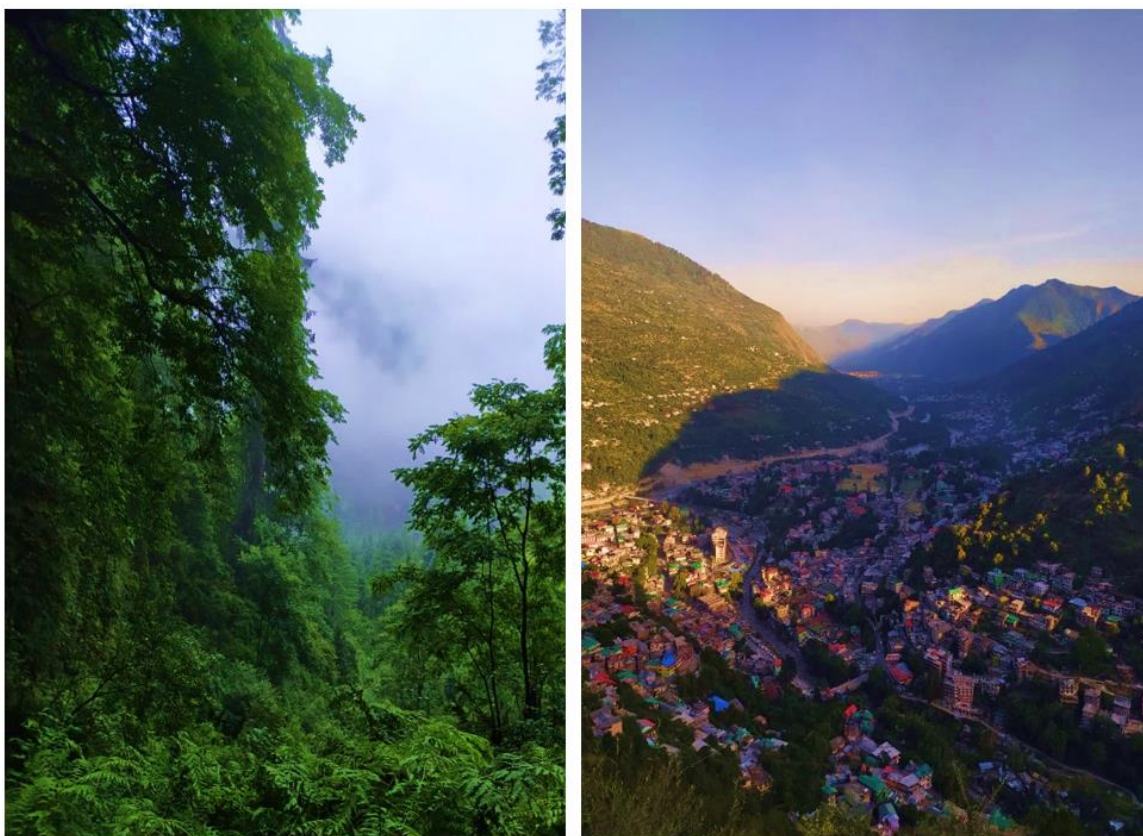
Plants play a vital role in various aspects of human life. The Western Himalaya is an abode of diverse and incredible floral variety, including luxuriant pteridophytes, which have been neglected since ancient times due to limited knowledge. However, some fern species are utilized for their food value and medicinal properties. The fronds of *Diplazium esculentum* (Retz.) Sw., locally known as 'Lingadi,' are popularly used for various purposes by the local communities of the Kullu Valley in Himachal

Pradesh. Traditional and indigenous use, both as food and medicine, has been passed down from generation to generation, leading modern-day individuals to realize the benefits of its consumption. Simultaneously, with modernization and urbanization, *Diplazium esculentum* is in high demand because it is among the traditional delicacies of the valley, known for its medicinal and immunomodulating properties, providing livelihood opportunities for the rural communities involved in lingadi-selling.

The present study area encompasses some villages in the Kullu district of Himachal Pradesh. *Diplazium esculentum* grows naturally along the shores of water bodies and in shady regions. Fronds are collected from March to May and preserved through sun drying and picking. It is widely distributed in temperate and sub-temperate regions of the valley at altitudes ranging from 1200m to 2500m above sea level. In addition to its traditional indigenous use, recent research has shown evidence of its medicinal properties through phytochemical analysis, revealing chemical properties and biological activities that aid in curing diseases and boosting immunity (Dash et al., 2017). The study aims to conserve and sustainably utilize the fern for maintaining ecological balance.

Study area

The study is carried out in various regions of the Kullu valley at different levels viz., village, panchayat and block level. Kullu valley is located within the geo- coordinates of 31.2432°N and 32.2432°N latitude and 77.1455°E and 77.1892°E longitude covering an area about 3,561 sq. kms. Study area includes places like Lug- valley, Kothi Sari, Khrahal, Kais, Raison, Fojal, Patlikuhal, Naggar, Khakhnal, Bran, Kanyal, Solang, Chichoga in from December 2021 to March 2022 (Figure 1).



Study area showing Luxuriantly growing Pteridophyte Flora

View of Kullu valley

Figure 1 Location of study area

2. MATERIALS AND METHODS

The study is based on both primary and secondary data collection from the study area. The standard ethnobotanical method is employed for field surveys. Associated traditional knowledge and medicinal values are documented through interviews with

traditional knowledge holders, vairs, hakims, and traditional medicinal practitioners (Figure 2). Group discussions were conducted at the panchayat and village levels. Different tribal communities, namely the Lahauli and Kinnauri communities, residing in the area were also interviewed to gather first-hand information. A total of 27 informants were interviewed, consisting of 7 males and 20 females, as detailed in (Table 1). Phytochemical information is obtained from a review of secondary data. Plant material is collected, and fresh fronds are preserved in a 70% formalin solution. The fronds are then dried and pasted onto herbarium sheets. Pickled and dried fronds are collected as samples.



Figure 2 Field view and community consultation in the study area

Table 1 Details of informants consulted during the ethnobotanical survey of Kullu Valley

| Sr. No. | Name | Age | Gender | Occupation | Address |
|---------|---------------|-----|--------|--------------------------|--|
| 1 | Karma Devi | 55 | Female | Agriculture | Village Raison Distt. Kullu (Khrahal) |
| 2 | Shobha Devi | 66 | Female | Foraging and agriculture | Village Kais Distt. Kullu (Khrahal) |
| 3 | Asha Devi | 43 | Female | Shopkeeper | Village Archandi Distt. Kullu (Naggar) |
| 4 | Anup Ram | 47 | Male | Shopkeeper | Village Durganagr Distt. Kullu (Kothi- Sari) |
| 5 | Vandana | 55 | Female | Housewife | Village Jagatsukh, Distt. Kullu (Manali) |
| 6 | Jaybanti Devi | 41 | Female | Housewife | Village Durganagr Distt. Kullu (Kothi sari) |
| 7 | Shukra deen | 45 | Male | Vaid | Village Jonga Distt. Kullu (Lug Valley) |
| 8 | Vimal Kishor | 28 | Male | Teacher | Village Shalang Distt. Kullu (Lug valley) |
| 9 | Nirmala Devi | 44 | Female | Housewife | Village Katrain Distt. Kullu |
| 10 | Monark Thakur | 24 | Male | Student | Village Sajla Distt. Kullu (Manali) |
| 11 | Preeti | 38 | Female | Ward member | Village Khakhnal Distt. Kullu (Manali) |
| 12 | Sansar Chand | 58 | Male | Traditional | Village Sheldi Distt. Kullu (Fojal) |

| | | | | Knowledge holder | |
|----|----------------|----|--------|------------------------------|---|
| 13 | Shashi Kanta | 59 | Female | Traditional Knowledge Holder | Village Patlikuhal Distt. Kullu |
| 14 | Butti Devi | 91 | Female | Traditional knowledge holder | Gompa road, Manali Distt. Kullu (Manali) |
| 15 | Ganga Devi | 40 | Female | Housewife | Village Ghurdaur Distt. Kullu (Naggar) |
| 16 | Godawari | 52 | Female | Pickle seller | Village Katrain Distt. Kullu |
| 17 | Sonika | 42 | Female | Housewife | Village Dobhi Distt. Kullu |
| 18 | Sudesh Kumari | 56 | Female | Housewife | Village Angudobhi Distt. Kullu (Kharahal) |
| 19 | Joginder Singh | 67 | Male | Farmer | Village Nathan Distt. Kullu (Lug valley) |
| 20 | Maya Devi | 50 | Female | Foraging, Housewife | Village Chichoga Distt. Kullu (Manali) |
| 21 | Leela Devi | 68 | Female | Housewife | Village Chichoga Distt. Kullu (Manali) |
| 22 | Aangmo Devi | 70 | Female | Housewife | Village Bhekhli Distt. Kullu (Kothi sari) |
| 23 | Vidya Devi | 64 | Female | Housewife | Village Bran Distt. Kullu |
| 24 | Sheela Devi | 46 | Female | Housewife | Village Badagran Distt. Kullu |
| 25 | Ruaudi Devi | 60 | Female | Fronde seller | Village Balohni Distt. Kullu (Kothi sari) |
| 26 | Panna Lal | 46 | Male | Farmer | Village Shanag Distt. Kullu (Manali) |
| 27 | Shakuntla Devi | 56 | Female | Housewife | Gompa road, Manali Distt. Kullu |

3. RESULT AND DISCUSSION

Diversity and distribution

Diplazium esculentum (Retz.) Sw. is found luxuriantly growing in all the surveyed regions in the valley, at different altitudes ranging from 1200m to 2500m above sea level. It thrives near water streams, in shady areas along the shores of water bodies, and in the canopy of other plants. Its habitat encompasses proximity to water streams, shaded areas along the shores of water bodies, and within the canopy of other plant species. The opportune time for frond collection extends from March to early May when the fronds are at their freshest and most tender state. A graph illustrating the abundance of *D. esculentum* in different study sites based on harvest and use is presented in (Figure 3). Lug Valley exhibits a greater abundance compared to Kothi Sari, Manali, followed by Naggar and Fojal, respectively. This observation underscores the varying prevalence of *D. esculentum* in different locations within the surveyed valley.

Wild-edible and ethnobotanical uses of *Diplazium esculentum*

Diplazium esculentum is used as a vegetable in the valley and holds a significant place among the local delicacies. Stir-fried Lingadi, Lingadi raita, and Madra are commonly prepared dishes. It has become a staple in the main course menu of restaurants as part of Himachali cuisine, gaining popularity among tourists. The collected fronds are sun-dried and stored in a moisture-free container for future use in making soups, vegetables, and other dishes during the off-season when fresh fronds are not readily available. Additionally, Lingadi fronds are pickled, commonly known as 'lingadi ka aachar', and are available in the market, with local market values detailed in (Table 2). The pickled fronds are sold in various regions across the country. There is a high demand among locals and tourists alike due to its natural occurrence, significant medicinal values, and absence of contamination and artificial preservatives (Figure 4, 5 & 6). The value of this fern is higher in other states compared to the local market, thereby providing and ensuring livelihood opportunities for the local community in the Kullu valley.

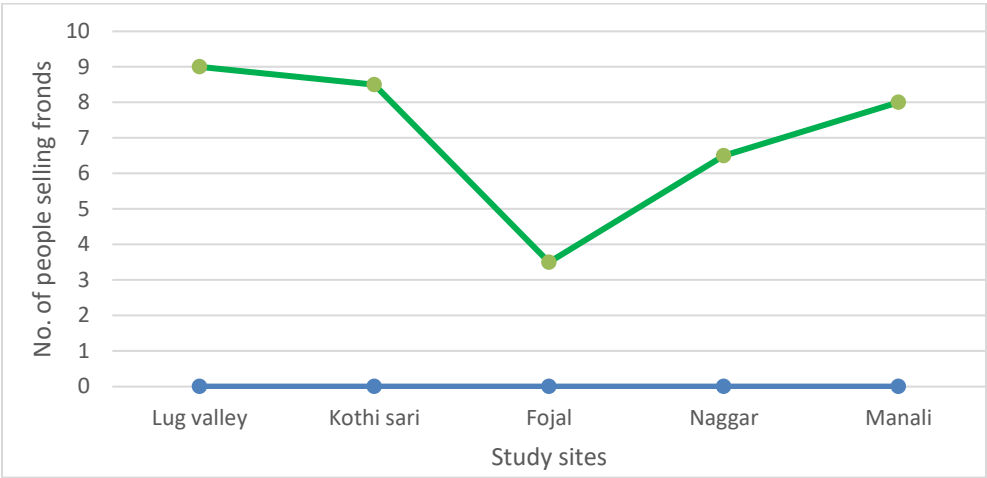


Figure 3 Abundance of *D. esculentum* on the basis of harvest and use in study area



Figure 4 Uses of *D. esculentum* in Kullu Valley

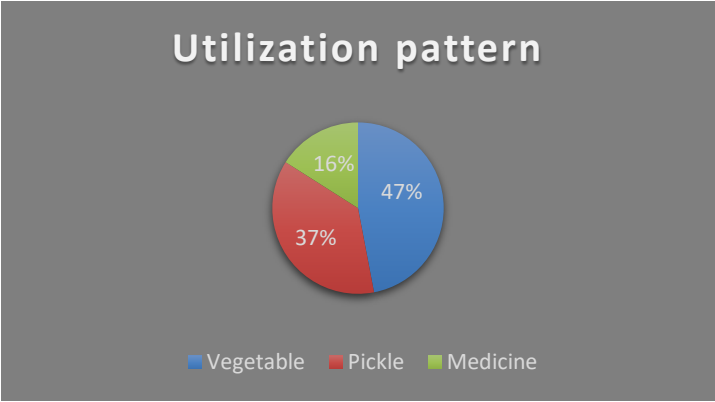


Figure 5 Utilization pattern of *D. esculentum* fronds

Table 2 Market value of *Diplazium esculentum* in Kullu valley and other parts of the country

| Sr. No. | Available form | Price per kg in Rs. In local Markets | Price per kg in Rs. in other states |
|---------|----------------|--------------------------------------|-------------------------------------|
| 1 | Fresh frond | 40-80 | - |
| 2 | Dried Fronds | 200-300 | 400 |
| 3 | Pickle | 300-500 | 350-500 |

Medicinal properties

Diplazium esculentum (Retz.) Sw. is a traditionally used plant in local healthcare by traditional medicine practitioners in the Western Himalayas. Since ancient times, its fronds have been utilized to treat various diseases such as fever, cough, and cold. In the form of a decoction, it is consumed twice a day. In cases of constipation, it is used as a vegetable, although some people believe it can help with diarrhea. Moreover, it improves metabolic functions and enhances bowel movements. Additionally, it possesses antispasmodic properties. This plant is also known to cure asthma, respiratory diseases, and contribute to bone health. In the event of ligament dislocation or a mild fracture, a soup made from it is consumed, providing relief from inflammation and swelling. Moreover, it imparts a warming effect on the body and is consumed for its immunity-boosting properties (Sarkar et al., 2018).

Phytochemical properties and biological activity

Diplazium esculentum (Retz.) Sw. possesses a wide range of phytochemicals, including alkaloids, anthraquinones, anthraquinone glycosides, cardiac glycosides, cyanidins, flavonoids, glucosides, leucoanthocyanins, phenolic compounds, phytosterols, saponins, steroids, tannins, and terpenoids. The roles of major phytochemicals are detailed in (Table 3). Additionally, the phytonutrient values of *Diplazium esculentum* are presented in (Table 4).

Table 3 Phytochemicals and biological activity of *Diplazium esculentum*.

| S. No. | Phytochemical | Biological activity |
|--------|--------------------------|---|
| 1 | Alkaloids | Act as nervous system stimulator |
| 2 | Anthraquinones | It helps in providing relief in constipation. |
| 3 | Anthraquinone glycosides | They possess antibacterial, antiparasitic, insecticidal, antifungal, antiviral and diuretic properties. |
| 4 | Cardiac glycosides | They are useful in cardiac dysrhythmia and improves heart health also prevents heart failure. |
| 5 | Cyanidins | They enhance metabolic activity and having antioxidant properties. |
| 6 | Flavonoids | They possess antioxidant properties and prevents from stress and also have |

| | | |
|---|--------------------|--|
| | | anti- inflammatory properties. |
| 7 | Glycosides | They are used for medication in case if cardiac failure. |
| 8 | Phenolic compounds | They protect from chronic diseases and produces free radicals. |
| 9 | Phytosterols | They are having immune- modulating properties. |

(Source: Roy and Chaudhuri, 2020)

Table 4 Phyto -nutrient value of *Diplazium esculentum*

| S. No. | Nutrients | Content |
|--------|---------------------|------------------|
| 1 | Protein | 52.31% |
| 2 | Carbohydrate | 28.15% |
| 3 | Total sugar | 0.86 5 |
| 4 | Total Fat | 0.25% |
| 5 | Vitamin C | 46.0 mg/100g |
| 6 | Sodium | 1.18 mg/100g |
| 7 | Calcium | 12.25 mg/100g |
| 8 | Iron | 10.71 mg/100g |
| 9 | Total Dietary fiber | 17.44% |
| 10 | Energy | 324.13 Kcal/100g |

(Source: Gupta et al., 2020)



Leaves of *Diplazium esculentum* (Retz,) Sw.



A local woman engaged in foraging fronds of *D. esculentum*



The Shady region showing Pteridophyte flora.



Harvested Fronds



Harvested fronds kept for sun drying



Cooked fronds of *D. esculentum*

Figure 6 *D. esculentum* collection and preparation of local cuisine in the study area

4. DISCUSSION AND CONCLUSION

The study sheds light on the multifaceted aspects surrounding *Diplazium esculentum* (Retz.) Sw. in the Western Himalayas, emphasizing its traditional use, nutritional richness, escalating demand, and the challenges related to sustainability. The research findings underscore the fern's dual role as a vegetable and medicinal resource, emphasizing its rich phytochemical composition known for its therapeutic benefits. The diverse array of phytonutrients present in *Diplazium esculentum* not only enhances its medicinal value but also signifies its high nutritional content, promoting immune health. During the Covid-19 pandemic, its demand has increased over the last two years, providing rural communities with livelihood opportunities. However, the study reveals a concerning trend of unsustainable exploitation driven by this increased demand, resulting in a notable decline in regeneration. The adverse effects of climate change further compound this issue, influencing the fern's renewal process and causing a decrease in overall growth and availability.

In response to these challenges, our study advocates for strategic measures, specifically commercialization through value addition and quality improvement. These proposed interventions aim to fortify the fern's value chain and create enhanced livelihood

opportunities in the rural regions of Himachal Pradesh. The present work also underscores the significant role played by Lingadi pickle and Lingadi as part of Himachali cuisine, acting as catalysts in bolstering the fern's demand and popularity among tourists. There is also urgent need of adoption of sustainable harvesting and utilization methods to ensure the conservation of *Diplazium esculentum*. These strategies are deemed essential for preserving this economically and ecologically vital fern within the fragile ecosystem of the Himalayan region.

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Author contribution

Subodh Negi: Carryout the field survey and data analysis and drafted the manuscript

Kanwal KS: Conceptualize the study and reviewed the manuscript

Informed consent

Not applicable.

Ethical approval

The ethical guidelines for plants & plant materials are followed in the study for species collection & identification.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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